PROGRIS RIPORT 13

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`itehu:~kotani/glast/txt/010306.kotani2.riport13`

1 Have Done

- Confirmed that the three ntuples Fit_x0, Fit_y0, and Fit_z0 can be used to distinguish high-energy photons from high-energy electrons.
- Found that the distribution of Cs_Xtal_Ratio ntuple is energy dependent.

2 Distinguish photons from electrons

An incident photon makes a detectable track starting from a certain point inside a detector, while an incident electron makes a detectable track as soon as it enters the detector. It is possible to distinguish the two species by the difference in their tracks even in the high-energy range. Considering that, the distributions of ntuples Fit_x0, Fit_y0, and Fit_z0 were studied, and a simple filter on them is made and tested. As shown below, the filter successfully cuts more than half of high-energy electrons.

According to the Ntuple Description (Suson 2000/05/24), Fit_x0, Fit_y0, and Fit_z0 are defined as the coordinate of the RC initial vertex of the best track. What the mysterious RC initial vertex means is under investigation. Anyway, Fit_x0 etc. are supposed to express the starting point of the detectable track of an incident particle, if no problem in the reconstruction process. The distribution of Fit_z0 for electrons and photons is shown in Fig. 1. Each peak in the figure corresponds to a tracker layer. The electron distribution jumps up at the right end, where the top layer is. That is probably due to electrons entering from the top. The positions of each initial vertex on the top layer and on the others are plotted in Fig. 2 and 3. The distribution of the vertex of photons has no obvious pattern, while electron vertexes are concentrated on the top layer and in the edge of Fig. 3, i.e., the edge of the tracker. These figures shows that electrons are distinguishable from photons with Fit_x0 etc.

It's easy to cut events with an initial vertex on the top layer. I applied a simple condition "Fit_z0 $<$ 48" to events and removed a fraction of electrons. The merged distribution of Fit_x0 and Fit_y0 of remaining electrons is shown in Fig. 4. The peak at the left end is considered to be due to the events entering the tracker from a side. (What are other events? Under investigation.) The appropriate cut condition of the events entering from a side is not trivial, because it depends on the relative ratio of high-energy electron events to high-energy photon events. The problem is that we don't know the ratio until the GLAST is launched. Here i adopt a cut value of 70 cm and test the value with electrons and photons. The definition of the new filter (initial vertex filter?) is shown in Table 1. The HiCAL filter is introduced because the initial vertex filter should be applied for high-energy events with significant calorimeter signals. The result is shown in Table 2 and 3. It is remarkable that more than half of electrons of a heavenly origin is reject by the initial vertex filter, while 90 % of photons is accepted. Although a further calibration is necessary, this test shows that it does work.

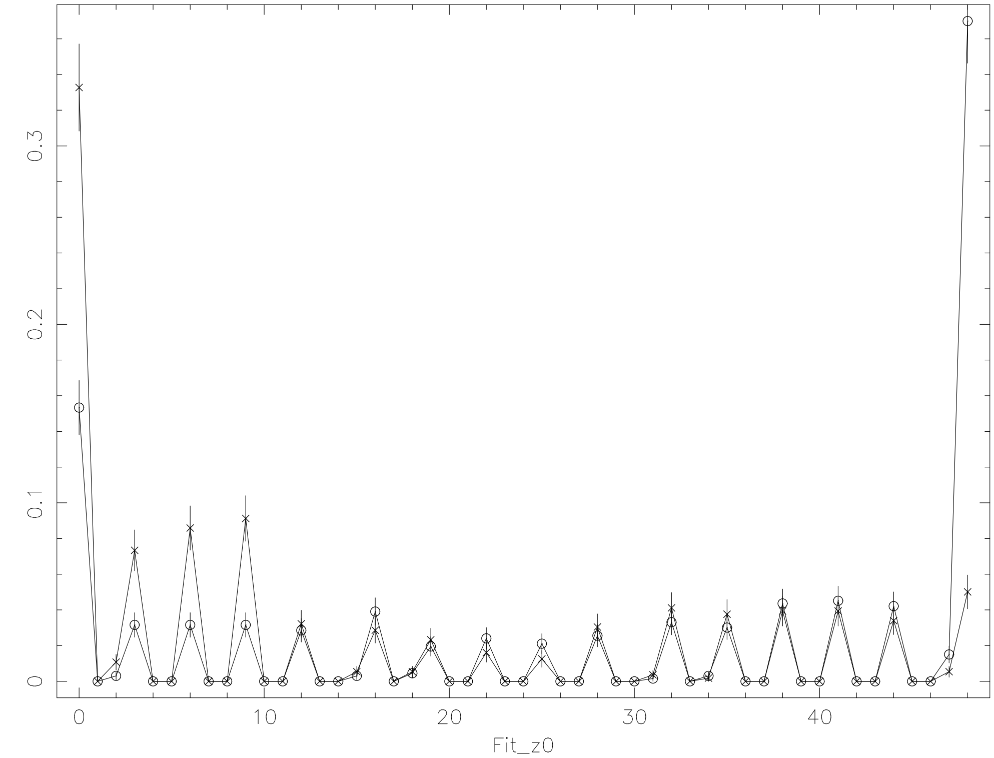

Figure 1: The distribution of Fit_z0
The distribution of 300 GeV electrons (◯) and 300 GeV photons (×) is plotted. The azimuthal angle was set to be less than 113°, i.e., a heavenly origin is assumed. The data points at Fit_z0 = 0 correspond to events with "no best track. No cut is applied.

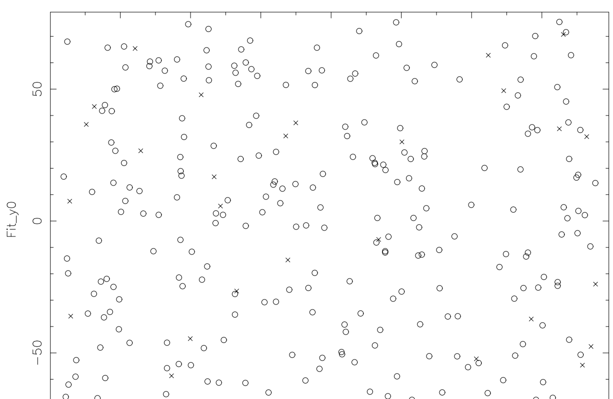

Figure 2: Initial vertexes on the top layer
The initial vertexes of 300 GeV photons (×) and 300 GeV electrons (◯) on the top layer are plotted. Out of 2000 generated photons, 28 photons have an initial vertex on the top layer, and 246 electrons out of 2000 have an initial vertex on the top.

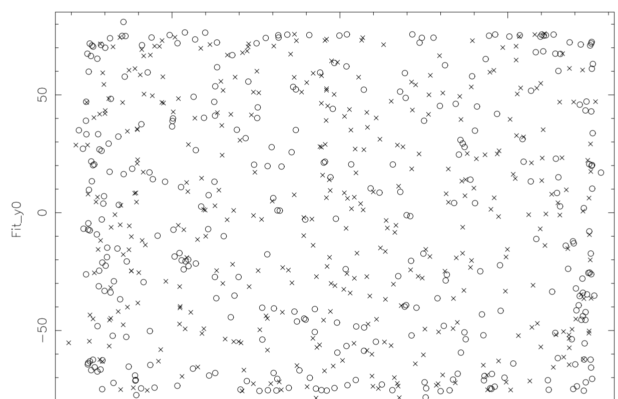

Figure 3: Initial vertexes on the other layers
381 photons (×) and 340 electrons (◯) have an initial vertex on the other layers.

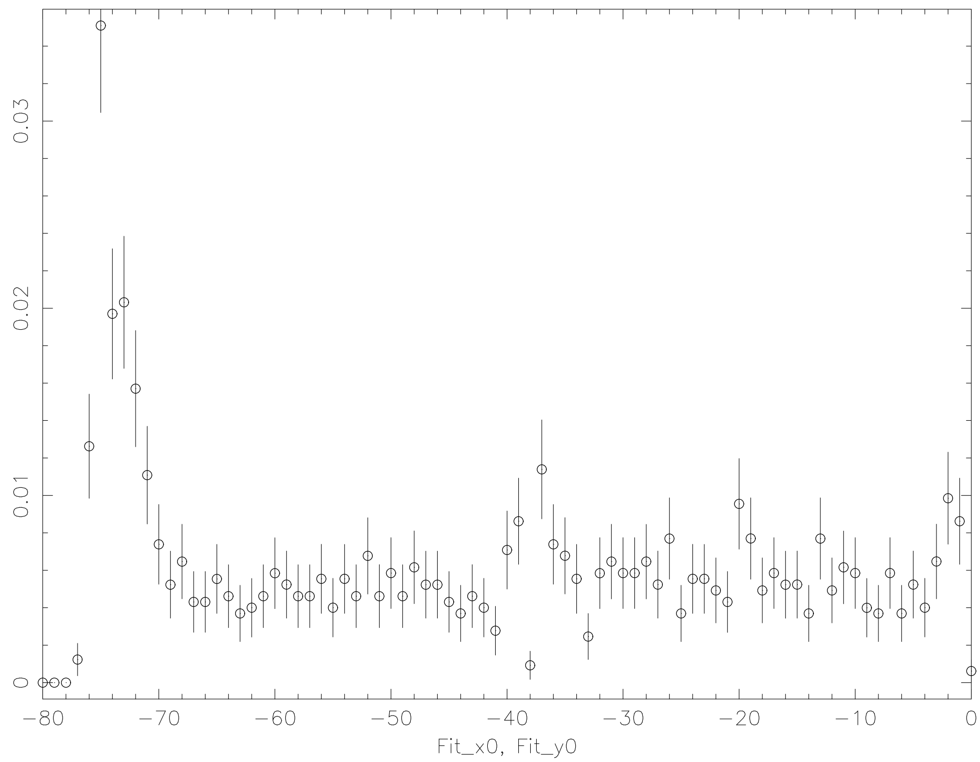

Figure 4: The merged distribution of Fit_x0 and Fit_y0
The distributions of Fit_x0 and Fit_y0 of 300 GeV electrons are merged and plotted. The right half (Fit_x0, Fit_y0 > 0) is folded into the left half and omitted from the figure. The vertexes on the top layer are not used in the plot.

Table 1: Triggers and filters

Name	Code/Definition
L1T	bit4 | bit64
	bit4: Any three x-y pairs in a row (TKR).
	bit64: LoCAL (1 log above threshold)
L2T	(bit1 & $\overline{\text{bit2}}$ & $\overline{\text{bit4}}$ & $\overline{\text{bit8}}$) | HiCAL
	bit1: A track candidate was found.
	bit2-8: A corresponding ACD tile was lit.
	HiCAL: 5 logs above threshold.
New L3T	(No_Tracks > 0 && Veto_DOCA > 25) || HiCAL
HiCAL	HiCAL
Initial Vertex 0	Fit_z0 > 70
1	(| Fit_x0 | < 70) && (| Fit_x0 | < 70)

Table 2: Initial vertex cut on 300 GeV electrons
Left: azimuthal angle $< 113°$. Right: Only the top of the GLAST is illuminated.

	Cosmic		Onto Top	
Generated	1	8000	1	4000
L1T	$(3.451 \pm 0.066) \times 10^{-1}$	2761	$(7.69 \pm 0.14) \times 10^{-1}$	3077
L2T	$(2.311 \pm 0.054) \times 10^{-1}$	1849	$(5.71 \pm 0.12) \times 10^{-1}$	2284
New L3T	$(1.856 \pm 0.048) \times 10^{-1}$	1485	$(4.30 \pm 0.10) \times 10^{-1}$	1722
Hi CAL	$(1.853 \pm 0.048) \times 10^{-1}$	1482	$(4.30 \pm 0.10) \times 10^{-1}$	1720
Initial Vertex 0	$(1.341 \pm 0.041) \times 10^{-1}$	1073	$(9.07 \pm 0.48) \times 10^{-2}$	363
1	$(8.69 \pm 0.33) \times 10^{-2}$	695	$(8.67 \pm 0.47) \times 10^{-2}$	347

Table 3: Initial vertex cut on 300 GeV photons
Left: azimuthal angle $< 104°$. Right: Only the top of the GLAST is illuminated.

	Cosmic		Onto Top	
Generated	1	2000	1	6000
L1T	$(2.80 \pm 0.12) \times 10^{-1}$	559	$(5.888 \pm 0.099) \times 10^{-1}$	3533
L2T	$(2.16 \pm 0.10) \times 10^{-1}$	432	$(5.228 \pm 0.093) \times 10^{-1}$	3137
New L3T	$(1.820 \pm 0.095) \times 10^{-1}$	364	$(4.303 \pm 0.085) \times 10^{-1}$	2582
Hi Cal	$(1.790 \pm 0.095) \times 10^{-1}$	358	$(4.063 \pm 0.082) \times 10^{-1}$	2438
Initial Vertex 0	$(1.770 \pm 0.094) \times 10^{-1}$	354	$(3.822 \pm 0.080) \times 10^{-1}$	2293
1	$(1.545 \pm 0.088) \times 10^{-1}$	309	$(3.755 \pm 0.079) \times 10^{-1}$	2253

3 The energy dependence of CsI_Xtal_Ratio

As shown in Table 1 in Riport 12, the CAL-Info filter rejects many high-energy photon events. This is not good. After plotting some distributions of ntuples, the CsI_Xtal_Ratio has been found to be the cause. For high-energy events, CsI_Xtal_Ratio tends to be smaller, and thus the events are rejected by the condition "CsI_Xtal_Ratio > 0.25" in the CAL-Info filter. This energy dependence has been recognized not only in GSFCACD4ROW but also in R990711. According to the source code, the ntuple is defined as

$$\begin{aligned}\text{CsI\_Xtal\_Ratio} &= \frac{\#\text{ of crystals hit}}{\text{estimated }\#\text{ of crystals hit}} \\ \text{estimated }\#\text{ of crystals hit} &= 10 + 2.7\log(\frac{\text{CsI\_Corr\_Energy}}{0.1}) \times \{1 + 0.15(1 - \frac{\text{fst\_X\_Lyr}}{\text{num\_trays} - 1})\}.\end{aligned}$$

There is no problem with the estimated number of crystals hit if the incident energy is less than 1 GeV, but it differs significantly from the real or simulated number of crystals hit in the high-energy > 10 GeV. Should i calibrate the estimation? Or the CAL-Info filter is not used for high-energy events and thus does not matter?

4 To Do

- Study the response of the calorimeter to high-energy events. Is a filter using the signals from the calorimeter to distinguish electrons from photons possible?
- Write a proposal or two for Chandra.

References

[1] D. Suson, 2000/05/24, Ntuple Description, /cvs/glastsim/doc/ntuple.html